PRACTICAL
MEASURING APPARATUS

MONOGRAPH B-3

SECOND EDITION, AUGUST, 1914

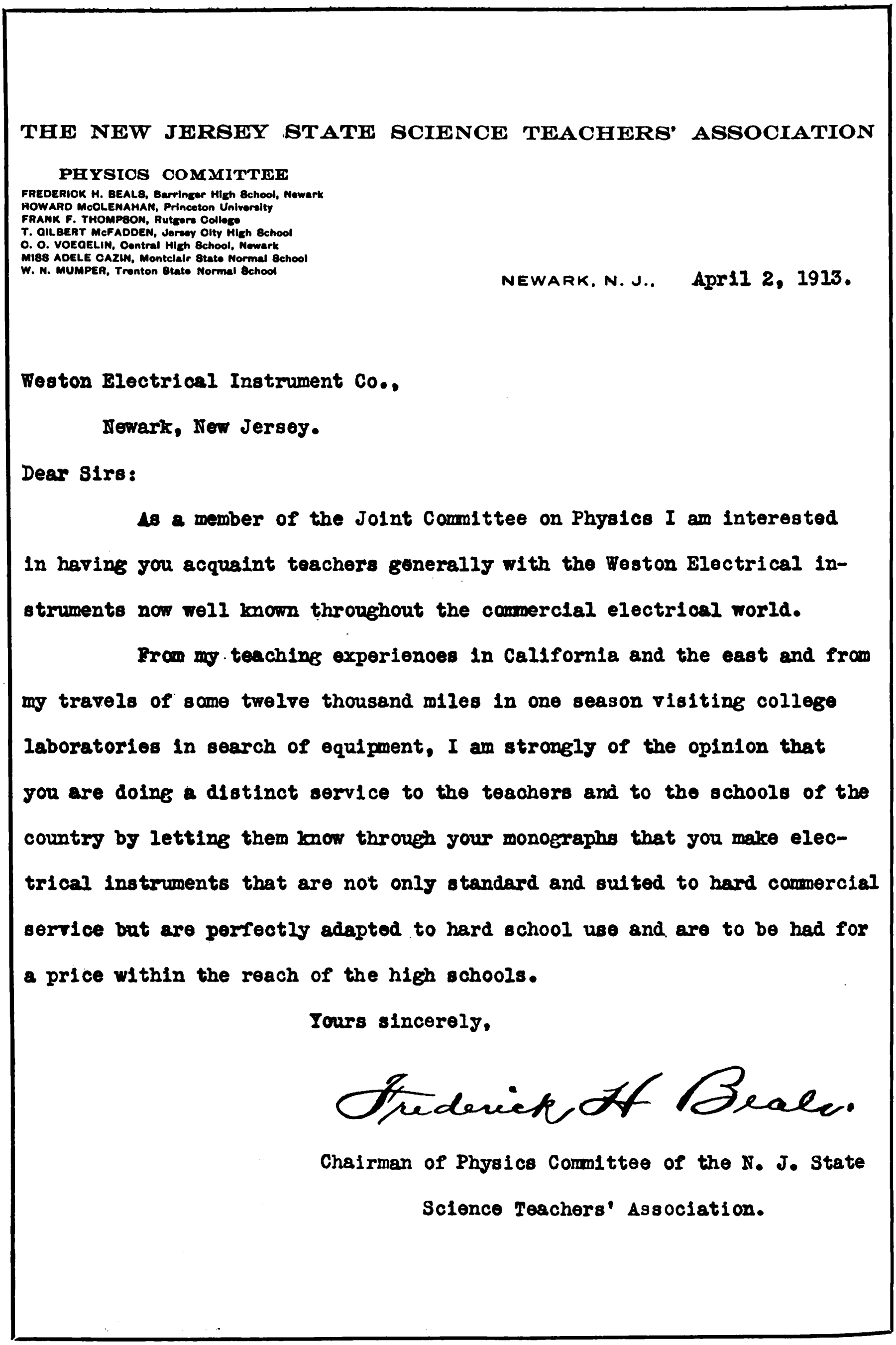
"ACCURACY is the first requisite for success in all original research, and accuracy cannot be attained when crude make-shifts are employed in place of standard apparatus."

WESTON ELECTRICAL INSTRUMENT CO.
NEWARK, N. J.

This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com



THE NEW JERSEY STATE SCIENCE TEACHERS' ASSOCIATION

PHYSICS COMMITTEE
FREDERICK H. BEALS, Barringer High School, Newark
HOWARD McCLENAHAN, Princeton University
FRANK F. THOMPSON, Rutgers College
T. GILBERT McFADDEN, Jersey City High School
O. O. VOEGELIN, Central High School, Newark
MISS ADELE CAZIN, Montclair State Normal School
W. N. MUMPER, Trenton State Normal School

NEWARK, N. J., April 2, 1913.

Weston Electrical Instrument Co.,
Newark, New Jersey.

Dear Sirs:

As a member of the Joint Committee on Physics I am interested in having you acquaint teachers generally with the Weston Electrical instruments now well known throughout the commercial electrical world.

From my teaching experiences in California and the east and from my travels of some twelve thousand miles in one season visiting college laboratories in search of equipment, I am strongly of the opinion that you are doing a distinct service to the teachers and to the schools of the country by letting them know through your monographs that you make electrical instruments that are not only standard and suited to hard commercial service but are perfectly adapted to hard school use and are to be had for a price within the reach of the high schools.

Yours sincerely,

Frederick H. Beals.

Chairman of Physics Committee of the N. J. State
Science Teachers' Association.

CONTENTS

PAGE
Switchboard Ammeters and Voltmeters for Direct Current. Model 24. 89
Portable Wattmeters. Model 310 90
Portable Voltmeters or Ammeters. Model 45 91
Classroom Voltmeter and Ammeter for Direct Current 92
Vertical-Scale Portable Instruments 94
Student Galvanometer. Model 324 96
Student's Galvanometers. Model 375 97
Miniature Precision Instruments. Model 280 98
Portable A. C. and D. C. Ammeters and Voltmeters. Model 155 99
A. C. Switchboard Instruments 101

PRACTICAL MEASURING APPARATUS

THIS Monograph contains a description of several models of Standard Weston Indicating Instruments that have been specially selected to meet the requirements of high school laboratory and lecture work. We desire to impress science teachers with the fact that the instruments herein specifically recommended are identical in principle and construction with the Weston instruments which the student will be required to use and understand later in practical work. The instruments referred to possess all of the characteristics of excellence relating to mechanical and electrical design and workmanship peculiar to all Weston products.

These instruments are guaranteed, and the service they will render with respect to accuracy, sensitivity and durability cannot be equaled by apparatus of other manufacture.

No attempt has been made in this monograph to offer a detailed description of the instruments illustrated, because such information is given in complete catalogs with price lists, which will be mailed upon request.

It will give the Technical Staff of this Company the greatest pleasure to be of any possible assistance to all instructors who intend to modify, extend or introduce a course in physics. If they will write to us giving all essential details, we will promptly send information in relation to the electrical apparatus that should be procured, and when feasible we will advise from whom it may be purchased to the best advantage.

Any suggestions we may make in relation to obtaining apparatus not of our manufacture will necessarily be unbiased and disinterested, since we are neither manufacturers of nor dealers in electrical supplies, and our business is strictly limited to the production of Weston standard and commercial electrical measurement apparatus.

Therefore it must be understood that our motive in recommending apparatus not of our manufacture is prompted only by a desire to assist instructors.

We purpose to improve the free services which we have always rendered to teachers. We extend a cordial invitation to all instructors to visit our factories and laboratories if possible.

Whenever feasible, we will, upon request, send a representative for the purpose of consulting with teachers, but where location prevents personal conferences, we will endeavor to give our best services by letter.

SWITCHBOARD AMMETERS AND VOLTMETERS FOR DIRECT CURRENT

1. These are typical switchboard instruments extensively used in light and power telegraph and telephone stations, laboratories, etc. See Figs. 1 and 2.

2. "Iron-clad" and designed to be unaffected by external magnetic fields.

3. Long and uniformly divided scale.

4. Dead beat movement, operated on the well-known Weston movable-coil and permanent-magnet principle.

MODEL 24 AMMETER

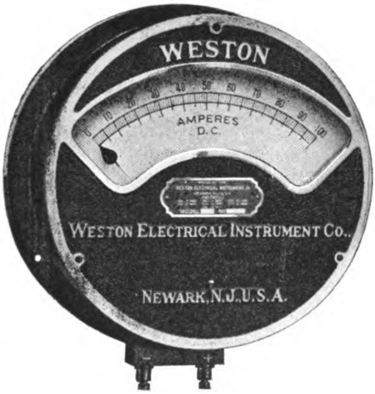


FIG. 1.

MODEL 24 VOLTMETER

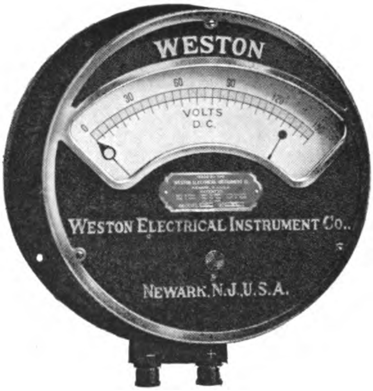


FIG. 2.

5. The ammeters are regularly furnished with self-contained shunts up to 200 amperes, but may be equipped with detachable external shunts if so ordered. If a series of external shunts of different capacities are ordered, one ammeter may be made to take the place of several, thereby obtaining the advantage which a number of instruments afford at a low cost.

6. The voltmeters have self-contained resistors for all ranges up to 300 volts.

7. Voltmeters can be furnished with two ranges such as 150 and 3. List prices are from $15 to $26.50, according to ranges of instrument required.

Complete prices, recommendations and specifications sent on application.

8. Guaranteed accuracy, 1 per cent.

WESTON PORTABLE WATTMETERS

Model 310

1. These instruments may be used on either direct- or alternating-current circuits.

2. They are shielded from external magnetic fields; and their indications are not influenced by changes in temperature.

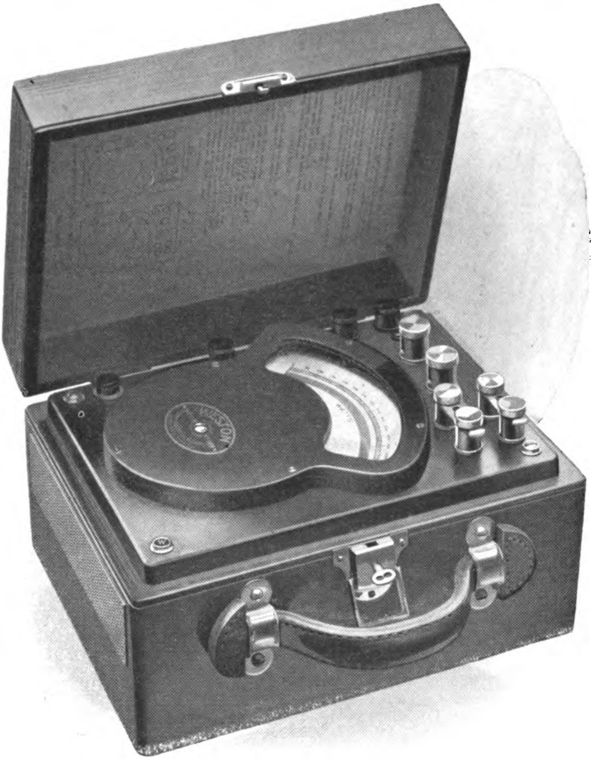


Fig. 3.

3. They are all made double range both in current and voltage, and in all capacities up to 75 K.W.

4. The current ranges can be changed by connecting the field-coil sections either in series or in multiple by means of links.

5. The field coils will stand an overload of 100 per cent

without undue heating and the potential coil may be overloaded 66 per cent.

6. The 2.5/5-ampere, 150/75-volt instrument is especially adapted for laboratory and experimental work. Its range is 750, 375 and 187.5 watts. The maximum current capacities are 5 and 10 amperes, and the maximum voltage 250 and 125.

7. The instrument is very useful for determining the power consumed by incandescent lamps and electrically heated devices such as flat-irons, toasters, water heaters, etc. It will also serve excellently for checking recording meters.

8. The subdivisions of the scales in these wattmeters are uniform throughout.

9. Guaranteed accuracy $\frac{1}{4}$ of 1 per cent. List price $70.

WESTON PORTABLE VOLTMETERS OR AMMETERS

MODEL 45

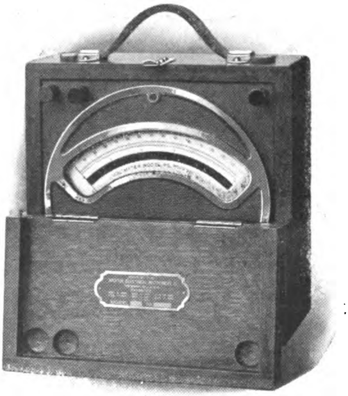


FIG. 4.

1. This is the same instrument which the student will be called upon to use in later practical work, and is therefore to be distinguished from makeshift indicators generally advocated by dealers. See Fig. 4.

2. It possesses all of the characteristics of excellence of mechanical and electrical workmanship and design common to all Weston products.

3. It is made and thoroughly guaranteed by the concern occupying the position of producing instruments that are commonly acknowledged to be the standards of the world, and is guaranteed to an accuracy of 1 per cent.

4. It is perfectly " dead beat," has a long scale and is direct reading.

5. It operates on the well-known permanent-magnet movable-coil principle.

6. The voltmeters may be made with one, two or three ranges, for example, for 150 volts; 150 and 3 volts or 300, 150 and 15 volts.

7. The ammeters may be made with one shunt self-contained or with a series of external shunts of different capacities, under which latter circumstance one instrument may be made to serve the purpose of several instruments of different ranges.

8. These instruments are "iron-clad" to shield them from the influence of external magnetic fields.

List prices are from $25 to $37 according to range of instrument required.

Complete catalog and price list sent on application.

CLASSROOM VOLTMETER AND AMMETER FOR DIRECT CURRENT

MODEL 323

This instrument has been specially designed for instructors' and students' use.

It combines in one mounting:

1. A voltmeter with with 3 ranges, 150, 15 and 3 volts.
2. An ammeter with as many ranges as may be desired.
3. A 0.050-volt millivolt meter.
4. A milliammeter (see description).

Model 323 has two separate and independent movements in one case, each provided with terminals and a 5-inch uniformly divided scale.

It is operated on the well-known Weston movable-coil, permanent-magnet principle.

It may be set at various angles by means of a thumbscrew, so that its scales will be perpendicular to the plane of vision. This feature makes it particularly suitable for classroom demonstration.

The finish is durable dull black japan, bringing out the scales in sharp contrast, so that they may be distinctly read at a considerable distance.

Zero adjusting devices are provided for each movement.

The voltmeter is regularly made in three ranges, 150, 15 and 3 volts, but other ranges will be supplied if preferred, at a slightly increased price.

The movable coils are very light, and their motion is practically dead beat, so that their pointers come to rest almost instantly after being deflected.

Model 323

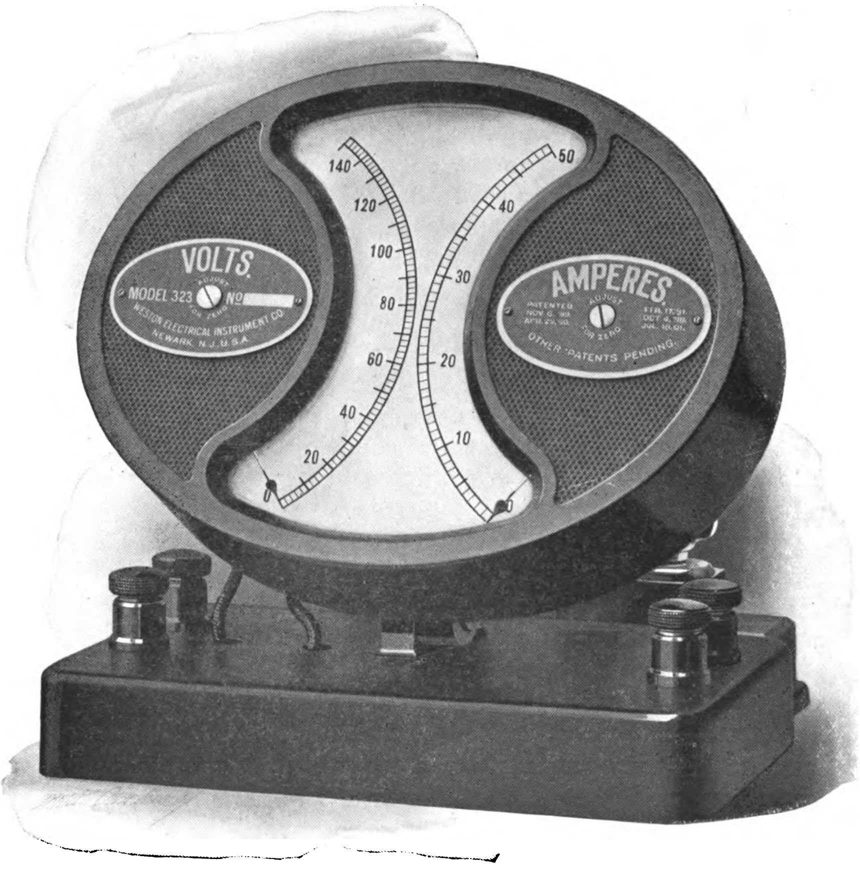


Fig. 5.

The ammeter movement is connected with the shunt in use by means of flexible leads and thumbscrews.

Shunts have a standard drop of 50 millivolts, and may be had in any range from 1 to 100 amperes, and can be easily attached or removed without tools.

The instrument is regularly supplied with two shunts, one having 10 amperes, and the other 1 ampere capacity.

Additional shunts of any desired range up to 100 amperes can be supplied; but since the ammeter has a scale with 100 divisions, we recommend that shunts be ordered of ranges which allow easy readings of the scale, for instance, 100, 50, 20, 5, 2, 1, or 0.5 amperes.

The unshunted ammeter may also be used as a milliammeter, giving a full deflection with 25 milliamperes.

The instrument is guaranteed to be correct within 1 per cent of full scale value for all ranges.

Price complete with two shunts $35 list.

Extra shunts 1 to 100 amperes, each $3.

WESTON VERTICAL-SCALE PORTABLE INSTRUMENTS

Model 264

The Model 264 is designed to stand in an upright position on a desk or shelf above a working table, and is made with a relatively heavy base in order that it may not easily be upset.

The scale is $4\frac{1}{8}$ inches in length and is vertical, and hence may be easily and clearly observed.

In general, the Model 264 instruments possess the same high order of merit as other Weston portable direct-current instruments.

Each instrument is equipped with a zero-correcting device, and connections are regularly made from the rear. The cases are handsomely finished in dull black enamel.

Model 264 instruments are made as galvanometers, millivoltmeters, voltmeters (range not to exceed 150 volts), milliammeters and ammeters with external shunts.

These instruments are especially valuable for students' use in laboratory work, and are particularly recommended for that service on account of their high accuracy, great durability, convenience and low cost.

A very useful instrument for the student is one calibrated 50–0–50 (zero-center 100-line scale), having a resistance of 2.5 ohms. The current required for full-scale deflection is .050 ampere, or .001 ampere per scale division. Such an instrument may be easily converted into a voltmeter by adding an external multiplier having a resistance of 20 ohms per volt.

Model 264 milliammeters have been made as differential instruments for use in balancing two circuits, and are extensively in use in this form in connection with telegraph bridge circuits. Other uses for these instruments will suggest themselves to electrochemists and to customers in general who have long sought a compact, readily movable and easily read instrument of high grade with a vertical scale.

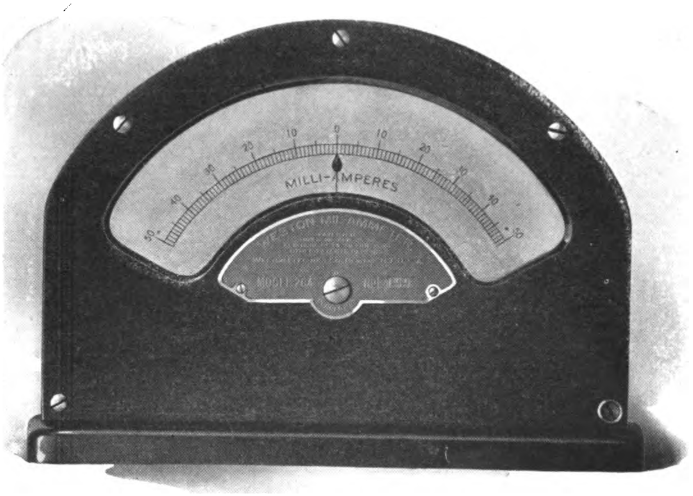


Fig. 6.—Vertical-scale Portable Instrument.

Price List:

Millivoltmeters ranging from 0–100 to 0-1000, zero in center or zero to left	$20.00
Voltmeters ranging from 0–1 to 0–150 volts, zero to left	20.00
Voltmeters (ranges as above) zero in center	21.50
Ammeters ranging from 0–1 to 0–150 amperes	23.00

(All ammeters having a range above 5 amperes are provided with external shunts having a drop of 50 millivolts. Ammeters up to and including 5 amperes are made with self-contained shunts.)

Milliammeters ranging from 0–50 to 0–750 milliamperes. $20.00

Ammeters and milliammeters may be had with zero in center, without extra charge.

An additional charge will be made for differential milliammeters.

A catalog giving lists of ranges regularly manufactured will be mailed on application.

WESTON STUDENT GALVANOMETER

Model 324

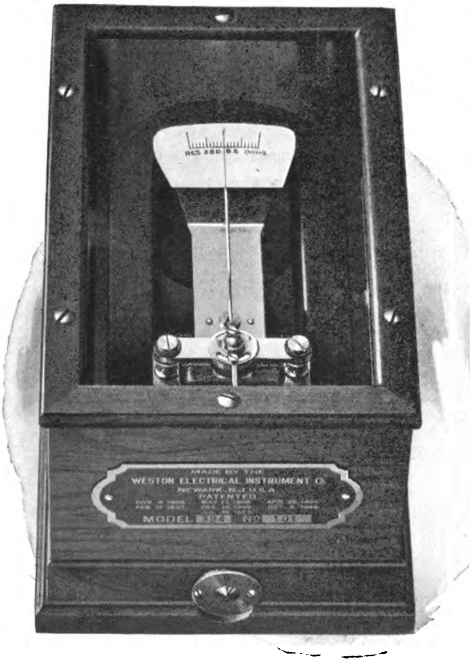


Fig. 7.

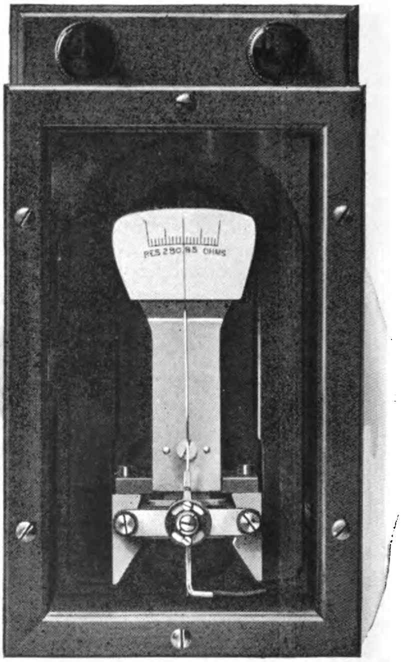


Fig. 8.

Designed and prepared with special reference to the requirements of students in high schools, training schools and collegiate preparatory schools.

This galvanometer meets a long-felt requirement for a thoroughly reliable yet extremely sensitive indicator of slight potential differences.

ADVANTAGES OVER SUSPENSION TYPES

1. Has an extremely concentrated magnetic field and a sensitivity such that it gives a scale deflection of 1 mm. with 1 volt through 500,000 ohms, and is therefore suitable for all accurate 4-decade Wheatstone bridge measurements.

2. Is exceedingly accurate, serviceable and durable and may be handled without risk of damage, and hence unless grossly abused, its lifetime is practically unlimited.

3. Reasonable in first cost and has practically no maintenance cost.

4. Direct reading and much more responsive than suspension-type reflecting galvanometers.

5. Has glass front so that principle of operation may be readily explained and understood.

6. Its readings may be readily interpolated, and therefore in emergency it may be used as a high-sensitivity milliammeter, etc.

7. Has a zero correcting adjustment.

8. If required same instrument can be furnished with three self-contained damping shunts at special price.

List price $18 each f.o.b. Newark.

WESTON STUDENT'S GALVANOMETER

MODEL 375

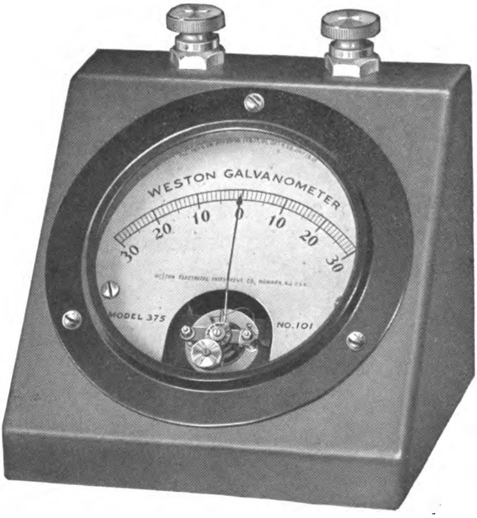


FIG. 9.

1. This instrument is of the permanent-magnet movable-coil type. It is mounted on a wooden base, at a convenient angle for reading.

2. It has a zero-in-center scale; length 30–0–30 millimeters.

3. An e.m.f. of 1 volt will produce current giving a deflection of 1 scale division through a series resistor of 62,500 ohms.

4. Current required for 1 mm. deflection is 16 microvolts.

5. Resistance of instrument is approximately 29 ohms.

6. This instrument may be used as a current detector or a galvanometer for Wheatstone bridge resistance measurements; as a means for measuring insulation resistance, for the measurement of very small currents, etc.

7. The accuracy obtained with it in bridge work for any resistances up to 2000 ohms is greater than ½ of 1 per cent.

List price, $9.

WESTON MINIATURE PRECISION DIRECT-CURRENT INSTRUMENTS

Model 280

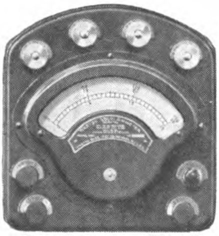


Fig. 10.—Model 280 Triple Range Portable Volt-Ammeter.

Although the instruments of this group are the same in principle and have the same mode of operation as the early and well-known Weston direct-current instruments, their general design and construction have been greatly changed and improved. The refinements of design and mechanical work in them have been carried to a degree which seems incredible and almost impossible of accomplishment.

List prices are from $12.50 for a single-range ammeter or voltmeter to $27 for a triple-range volt-ammeter, with intermediate prices according to the number of ranges required.

Bulletin No. 8, giving a complete description and price list of these instruments, will be sent upon application.

WESTON MINIATURE SWITCHBOARD VOLTMETERS, AMMETERS AND MILAMMETERS

MODEL 267

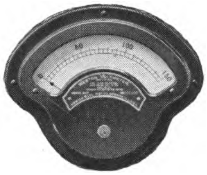


FIG. 11.—Model 267 Switchboard Voltmeter, Front View.

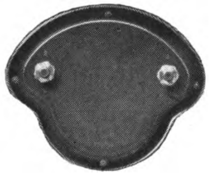


FIG. 12.—Model 267 Switchboard Voltmeter, Back View.

This group of instruments consists of a variety of ranges, of small switchboard ammeters and voltmeters suitable for use in small isolated plants, signal systems, battery charging panels, and for all kinds of service where small switchboard-indicating, instruments are needed, *and will also appeal to Science Teachers.*

Made only in single ranges, with back connections. See Figs. 11 and 12.

List price $10.50. Bulletin supplied upon request.

WESTON PORTABLE A.C. VOLTMETERS, AMMETERS AND MILLI-AMMETERS

MODEL 155

Although specially designed for alternating-current measurements, these instruments may also be used with direct current. See Figs. 13 and 14.

They are of the "soft-iron" or electro-magnetic type, and are so excellently constructed that they are superior to many imitations of the Weston direct-current permanent-magnet instrument.

They are remarkably accurate, and may be relied upon to within ½ of 1 per cent.

While primarily intended for A.C. work, they may be used with direct current with an average error of not more than 1¾ per cent.

These instruments necessarily do not have evenly divided scales, but are so contrived that their scales are almost absolutely proportional throughout about four-fifths of their length (the working part of the scale).

The moving system is exceedingly light and compact.

These instruments may be used on circuits of any frequency within the limits of engineering practice of to-day.

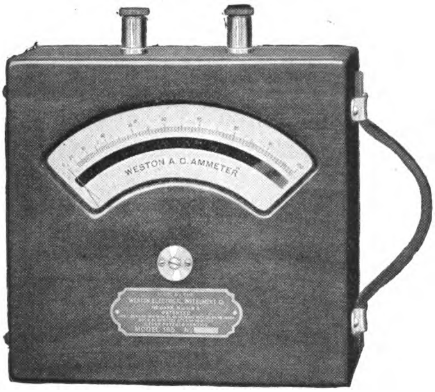


Fig. 13.

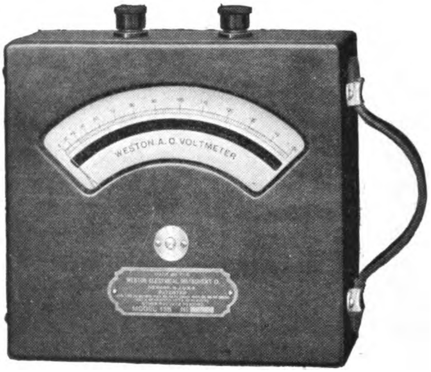


Fig. 14.

Their action is perfectly "dead beat."

They are extremely sensitive and quickly respond to the most minute as well as the greatest fluctuations in current strength or potential difference on the circuit.

List prices are from $17 to $30, according to range of instrument required.

Circular No. 7 giving a complete price list and description of these instruments, and also of similar ones designed for switchboard use, will be mailed on application.

WESTON A.C. SWITCHBOARD VOLTMETERS AND AMMETERS

MODEL 156

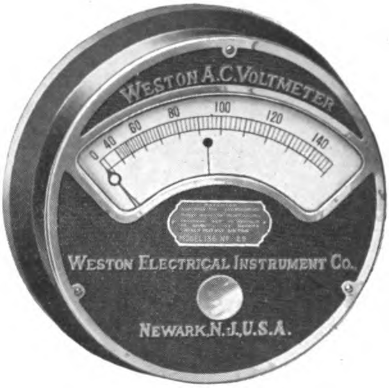


FIG. 15.

A FEW IMPORTANT POINTS OF SUPERIORITY OF THE MODEL 156 VOLTMETERS AND AMMETERS

These instruments are the two new lines intended for use as ammeters and voltmeters on alternating-current switchboards, but they may also be used with *direct-current*. They are of the "soft-iron or electro-magnetic type," but in their electrical and mechanical characteristics they are so far in advance of all preceding forms of soft-iron instruments as to mark a new epoch in that type of instrument.

1. *No Inductance Error.* That is, the errors in the indications of these instruments when used for all frequencies met with in ordinary engineering practice are entirely negligible.

2. *No Discernible Working Error.* That is, they indicate the same whether left in circuit for a minute, or permanently.

3. *No Chamber Error.* That is, the error for any reasonable change in the temperature of the surrounding atmosphere of the room or chamber where used is negligible. In fact a change of 100° F. will cause an error of less than ½ of 1 per cent on a voltmeter with a range of 150 volts.

4. ***Entirely Dead Beat.*** That is, they are in this respect the

equal of any of the permanent magnet direct-current instruments of Weston manufacture.

5. *Remarkably Uniform Scale.* In this respect also these instruments surpass all others. A reference to the facsimile scales will demonstrate that on the upper four-fifths portion of the scale (the working part) the divisions are so nearly uniform as to warrant this characterization.

6. All other sources or causes of error commonly found in instruments of the same class and now in general use, are either wholly eliminated or so far reduced as not to be discernible on the scale.

List prices are from $13.50 upwards, according to range.

Catalog giving complete description and price lists mailed on application.

The principle of operation of these alternating-current instruments is described in Monograph B-4, and beautiful phantom views of their interiors are shown.